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ABSTRACT

A readability study for the Albuquerque Technical-Vocational Institute (T-VI) was undertaken to provide information regarding the reading ability required to complete training and to function in entry-level jobs. Readability formulas were applied to materials used in training and on the job. In addition, students were tested for level of reading, and interviews were conducted in the field with T-VI graduates and their employers. The study included architectural drafting technology, office occupations, diesel mechanics, the health occupations, and the electronics technologies. To determine whether students could read occupationally specific reading materials, cloze tests were administered. The results indicated that students could read the material in their field even though their test scores on the Nelson-Denny Reading Test indicated they should have difficulty. The explanation appears to lie in the background knowledge and experience the students bring to reading in their own field as opposed to the general academic background knowledge needed for a standardized test. The study recommended that reading instruction should occur within the occupations as an integral part of the curriculum rather than being viewed as a remedial measure. Further impetus is given to this suggestion by the speed of change in every occupation studied. As electronics and computer use increase, job descriptions and the methods used in those jobs are changing, demanding flexible workers who can keep learning. (Author/KC)

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READABILITY STUDY

Robert White

William Jordan

June 1987

Albuquerque Technical-Vocational Institute

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READABILITY STUDY

ALBUQUERQUE TECHNICAL-VOCATIONAL INSTITUTE

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July 1987

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The material contained in this report does not reflect the views of the Albuquerque Technical-Vocational Institute, but rather was collected and presented by William Jordan and Dr. Robert White under contract to T-VI. As such, Jordan and White assume responsibility for the accuracy of the factual information as well as for the opinions expressed.

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ABSTRACT

The readability study was conducted to discover the reading levels of texts used in training and the materials read and written on the job. In addition, students were tested for level of reading and interviews were conducted in the field with T-VI graduates and with present employers of T-VI graduates to determine reading needs on the job and how T-VI can help students meet those needs.

The study included Architectural Drafting Technology, Office Occupations, Diesel Mechanics, the Health Occupations: Practical Nurse, Respiratory Therapy Technician, and Nursing Assistant, and the Electronics Technologies: Electronics, Instrumentation and Control, and Laser Electro-Optic Technicians.

To check whether students could read occupationally specific reading materials, cloze tests were administered. The results indicated that students could read the material in their field even though their test scores on the Nelson-Denny indicated they should have difficulty. The explanation appears to lie in the background knowledge and experience the students bring to reading in their own field as opposed to the general academic background knowledge needed for a standardized test.

Reading instruction should occur within the occupations as an integral part of the curriculum rather than being viewed as a remedial measure. Because workplace reading means accessing and using information, it is not a separate "skill" or "subject", but the basis for understanding and making decisions. As such, strategies of reading can be integrated as a help in the presentation of curricular material and not as an additional or overload course.

Further impetus is given to the last suggestion by the speed of change in every occupation studied. As electronics and computer use increase, job descriptions and the methods used in those jobs are changing, demanding flexible workers who can keeping learning. Workers who cannot read are going to be left behind.

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INTRODUCTION

The Readability Study for the Albuquerque Technical-Vocational Institute was undertaken to provide information regarding the reading ability required to complete training and to function in the entry-level job setting. To date, there has been no large-scale readability study performed which would give such information for an entire occupational field within both training and job settings.

To accomplish this task, three approaches were developed and used: (1) analyzing the reading material within training and on the job using standardized readability formulas, (2) interviewing employers and employees to gain an insight into the entry-level language requirements and to collect job-related reading materials, and (3) testing selected students at T-VI with standardized reading tests to determine specific reading levels and with cloze tests to determine ability to read required materials.

The three approaches were based on assumptions taken from the literature and discussions with the staff at T-VI. Some of the initial hypotheses were that:

1) Students who tested at a ninth grade level on a reading test could not read textual material at grade level 14.

2) Technical words raised the readability level of technical materials to artificially high levels when measured by formulas.

3) The reading skill of students would be generalizable at some level.

4) The support structure available to students while at T-VI would be missing when they went out on the job.

5) Technical reading materials would be more difficult for students to read than general materials.

This final report contains information in five areas: (1) a statement of methodology and instrumentation, (2) information relating to each of the occupational programs studied, (3) summary, (4) protocols for studying other occupational areas, and (5) dissemination activities. Within each occupational program, information is presented relating to readability of texts and job materials, student reading levels, interviews with employers and suggestions for improving reading in the program.

INSTRUMENTATION

Methodology

The Readability Study had four phases:

Phase One - collection of training materials and job materials.

Phase Two - selection of samples from training and workplace; application of readability formulas.

Phase Three - testing of students with standardized tests and cloze tests made from job reading samples.

Phase Four - synthesis of training and job readability levels and an assessment of reading levels needed in each area.

These four phases tended to occur simultaneously as the study progressed. The initial interviews served as a means to check the validity of interview instruments which were then refined for later use. In like manner, the readability formulas were applied to samples as those samples became available.

The overlapping of phases proved essential to a smooth program as there was always a new lead to follow or further information to be analyzed. The cloze test passage selection occurred late in the program after there was a good sense of the type of material suitable, based not only on readability level as measured by the formulas, but also on appropriateness for the chosen groups.

Student Reading Levels

The reading levels of the students were measured two ways: The Nelson-Denny Reading Test, a standardized reading test for use with reading levels 6 to 15, and cloze tests of material selected from texts and job material. Cloze tests are tests where actual reading material is selected and words are systematically deleted in the body of the text with the first and last sentences of the passage left intact.

The Nelson-Denny Reading Test

Because there is no standardized reading test designed to measure the reading ability of technical-vocational students, the Nelson-Denny Reading Test was selected for use in this study. With a possible range of scores from 6th grade to 15th grade, it was believed that this test was more appropriate than others with a more limited range. It is not without problems, however. It is used for predicting college success and for diagnosing reading problems of

college-bound students. It is, therefore, an academic test geared to the types of knowledge and background experiences that a college-bound student is expected to possess. This bias is reflected in the choice of vocabulary words and the reading selections for the comprehension part of the test. For example, while the vocabulary section appears to contain more accessible information for T-VI students than the comprehension section because the questions are discrete, requiring no reference or generalizing skills, it still contains such words and phrases as "symposium", "unmitigated", and a "blithe spirit", all distinctly academic in orientation. In fact, for T-VI students the vocabulary section scores were higher than the comprehension test scores just as they were for Sherrill (1981).

The comprehension section also reflects an academic orientation with reading passages on the Latin poets, astronomical theory, acoustics, European history, geologic time, architectural/art history, sociology, and philosophy. These are subjects about which many T-VI students would have little knowledge, background or interest. Even the one piece on architecture deals with the aesthetics of 17th century French design as reflected in the form of Versailles.

The point in noting these difficulties is only to say that there is a very real question of whether such a test is "culture fair" in the sense of testing the actual reading

ability of T-VI students. T-VI students are geared toward reading in the workplace, not reading in academia. To examine whether the Nelson-Denny fairly measured the reading ability of T-VI students, cloze tests were used to measure the students' reading ability in their own fields, taking into account their own interests and tying in with the materials that they study in class and will work with on the job.

The study indicates the occupations at T-VI break into two groups, each with its own particular problems. In the first group are the occupations which have readers which are not strong general readers but can read technical materials adequately with training. Problems occur when such readers encounter new material or material in which they have not been trained. This group contain Office Occupations, Architectural Drafting, Diesel Mechanics, and Nursing Assistants. The other group contains fairly strong general readers who must read new material in order to stay current in their fields. In this group are Practical Nurses, Respiratory Technicians, Electronics, Instrumentation and Control, and Laser Electro-Optic Technicians.

The findings indicate that overall, T-VI graduates can read adequately on the job as long as they remain in their area of training. There are areas, however, in each occupation which fall outside the technical curriculum, and there needs to be instruction in how to cope with these areas.

The use of readability formulas should be limited to only one part of any reading analysis. T-VI students in their areas of technical expertise can read several grade levels ahead of their general reading ability as measured by standardized instruments. Making a judgment purely on a readability formula is inappropriate.

Cloze Testing

Cloze testing is a method of systematically deleting words from a text and then measuring how well the student is able to fill in the blanks. In the case of the T-VI cloze tests, every fifth word was deleted from the text. In general, if a student can fill in 44-55 percent of the slots with exactly the deleted word, then the material is readable for instructional purposes. Over the 57 percent level, the material is appropriate for independent reading. The 44-57 percent levels correlate to the 75 and 90 percent levels on a standardized, multiple-choice comprehension test (Bormuth 1967, 1968; Rankin and Culhane, 1969).

Three types of cloze grading have been identified: exact, synonymic and appropriate. In exact grading only the precise word used in the original text is acceptable. In synonymic grading, a word is acceptable if it is grammatically and semantically like the word it replaces. Appropriate grading allows the person to use a word which fits the passage but may not have the exact meaning. An example from Architectural Drafting illustrates the three methods: "The vertical boards are _____ studs." The exact word is "called"; a synonymic word is "named" while an appropriate word is "wooden".

Exact grading has been used predominantly because it is easier, there being no question of scorer reliability, and

faster because there is no interpretation necessary. Studies have shown that there is no significant difference between the scores obtained by using exact grading and synonymic grading (Ruddell 1964; Asher et al 1976). Studies have largely chosen to ignore appropriate grading as an option, perhaps because it would be difficult for such a choice not to change the meaning in general English. In technical English there appears to be greater flexibility in appropriate usage while keeping to an exact meaning.

The cloze tests designed for the T-VI students were of varying types in order to see what was most useful as a means of testing. For Architectural Drafting and Office Occupations, one selection was made from textbook material and one selection from job reading collected from employers during interviews. The first test was purposely at an easy level to acquaint the students with this type of test as well as to give a low floor to the testing procedure. The second test in each case was at a professional/technical level in order to have a high test ceiling. It was believed that a greater discrimination of range could be made by having tests that were low and high rather than at a middle grade level.

Health Occupations and Diesel Mechanics each had technical cloze tests using job material collected during interviews. After finishing the cloze, students were given a completed copy of the cloze passage for a comprehension test

with hierarchically sequenced questions (based on the Bloom Taxonomy of the Cognitive Domain).

The Electronics group had a technical cloze based on related material, followed by a cloze test based on a general reading passage taken from the Albuquerque Journal.

By examining the results of the three types of tests administered, one type may emerge as the most useful for further use.

Readability Formulas

Readability formulas came into wide usage in the late 1940's and have provided educators with measures for determining reading levels of materials in quantitative form. Readability formulas are not without criticism, but when used with a valid sample, useful results can be obtained.

Because the formulas depend on the superficial quantitative measurement of letters, syllables, words, and sentences without regard to discourse structure, content, or the reader, readability formulas have been criticized as inadequate. As a complete measure, they are inadequate, but as a basis for comparison betweeen superficial aspects of various pieces of writing, they can be useful tools: every reader must move through the superficial aspects of a piece of writing to get to the content.

It should be noted that in interpreting readability scores, there is variability based on an inherent standard error of measurement as well as the selection of the text samples. By using four readability measures, the Dale-Chall, the Fry, the Raygor, and the Felsch, the standard error was minimized.

The Gunning-Fog Index was initially used, but it tested these materials at a much higher grade level compared with the other formulas and skewed the results. It is more appropriate at lower levels of reading measurement. Of the four chosen, the Dale-Chall was consistently the highest and the Fry the lowest, with the Flesch and the Raygor falling in the middle. It was believed that the average of the four would give more consistent results than any one formula by itself.

In addition to testing the passages in the normal manner for the readability formulas, the passages in Architectural Drafting and Office Occupations were tested again with the technical words deleted to examine to what degree the technical words raised the readability level of the text. It was believed that the technical words raised the readability level artificially high because of their length and repetitiveness. Because simply deleting the technical words from the text would skew the syllable, letter and word count severely, it was decided that the five letter, single syllable word "blank" would be inserted for

each deleted technical word. This would keep the letter and syllable count near the mean as well as keeping the word count accurate for the passage.

Results for each section will be presented in four parts: first the readability levels of the occupations; second, the test results; third, the interview data; and finally, a discussion of the implications for reading with a sample exercise for improving the reading skills of persons in the occupation.

RESULTS: ARCHITECTURAL DRAFTING

The results of Architectural Drafting will be presented in four sections: readability results, testing results, interview findings, and a summary of implications.

READABILITY RESULTS

Readability of the Text Materials

The results of the first part of the study are based on the collection of samples of reading material from texts used in T-VI and materials collected in the field. Materials ranged in difficulty from elementary school level to graduate school level, with about half of the textbooks at the college level.

In the study of textbooks, it was immediately apparent that there were two distinct types of materials. The first group consisted of standard texts: teaching materials designed for teaching and providing all of the features of school materials. The other group consisted of purely technical books designed for reference work on the job which were used for practice in training. The latter group included the Uniform Building Code, Uniform Plumbing Code, Uniform Mechanical Code, and National Electrical Code. While these books are used in teaching at T-VI and are

extremely important for students to know, they are not read any more than one reads a dictionary. They are reference books and have to be looked at in a different light from the texts used in courses. To this end, the readability levels listed in the report for Architectural Drafting will show the levels with and without the reference books included. Readability levels of the reference books will be included with on-the-job materials as well because they are essential to the proper functioning of a drafter on the job.

The textbooks ranged in reading level from elementary to advanced, specifically from grade level 6.4 for Carpentry Fundamentals to 15.9 for Mechanical and Electrical Equipment for Building. A listing of the books is presented here in ascending order of difficulty on the basis of the average of the four readability formulas:

Carpentry Fundamentals	6.4
Principles of Heavy Construction	10.1
Passive Solar	10.9
Technical Mathematics	11.0
Steel and Frame Building	11.4
Architectural Technology	12.6
Timber Building	12.7
Simplified Mechanics and the Strength of Materials	13.3
Manual of Concrete Detailing	13.6
Architectural Drawing	13.6
Precast Concrete Forms	15.0

Mechanical and Electrical Equipment for Building - 15.9

The reference books test at:

Uniform Building Code	13.5
National Electrical Code	14.7
Uniform Mechanical Code	15.3
Uniform Plumbing Code	15.4

Text Samples

The average readability was thus 12.4 without the reference guides. With the reference guides the difficulty increased by half a grade level to 12.9 for the 12 texts.

In addition to measuring the readability of the texts in the standard fashion, the readability of the same samples was tested without the technical words. For our purposes, technical words were defined as those words which were occupationally specific in usage. Thus they could be specific in all settings or simply context specific. An example of the first comes from Simplified Mechanics and the Strength of Materials: "the funicular polygon is constructed as indicated..." Clearly this is technical. An example of the latter type of deletion, the context specific, comes from Carpentry Fundamentals. "Start the first course with a full shingle." The word, "course", of itself, is not technical, but as used with regard to roofing, "course" has an occupationally specific meaning.

The results showed that the deletion of technical words lowered the reading levels an average of almost two grade levels--from 12.5 to 10.6 based on 26 text samples. This shows that the technical words are longer, and thus affect the readability scores to a great extent. It remains a question whether the technical words, of themselves, create a difficulty for the technical reader. Based on the results of the cloze testing, technical words do not seem to be a problem for the T-VI students sampled. In fact, it would appear that once students have learned a certain amount of technical information, the technical words are a support rather than a hindrance to their reading.

Not surprisingly, the results of the technical word deletion showed that the more words deleted, the greater the drop in reading level, especially when the deleted words were a phrase constituting a single concept. Generally, when only two or three words were deleted and no phrases, the difference in scores was within the grade level. By the time five deletions occurred, the difference was more than one grade level, and when eight words or several phrases were deleted, the difference was two or more grade levels.

Job Materials

Materials were collected from employers in the Albuquerque area which were representative of the materials which T-VI graduates will have to read when out on the job

after graduation. Samples from the collected material showed an average readability level of 14.7, or a little more than two grade levels more difficult than the average for text materials used at T-VI. This includes results of the samples of the reference guides as well as building proposals and zoning codes, regarding appropriate architectural design for a given area.

The job materials showed these average readabilities:

Uniform Building Code ---------- 13.5
Cielo Vista Condominiums Specifications- 14.1
National Electrical Code ---------- 14.7
Uniform Mechanical Code ---------- 15.3
Uniform Plumbing Code ---------- 15.4
Village Green Residential Rules -------- 16.8

The technical word deletion on these reference material samples (only five samples had deletions) showed that without deletions the material tested at 13.3 against a deleted score of 12.4. This represents a drop of .9 grade level, in contrast with the drop of 1.9 for the text material. Part of the explanation of this lesser drop can be attributed to the fact that the codes are largely legal descriptions rather than the technical explanations of texts. While the legal description is difficult language to read, the actual words themselves are not occupationally specific and, therefore, were not deleted while the

textbooks with their technical exposition had a greater number of occupationally specific usages which were deleted.

TESTING RESULTS

Nelson-Denny Test Results

The Nelson-Denny Reading Test was given to two groups of Architectural Drafting students. The sample of first trimester students read at an average grade level of 12.8. The fourth trimester students sampled read at an 11.9 grade level. As the table indicates, these results are not totally indicative of the whole of both classes. Several students who left early took the Nelson-Denny and not the cloze, and others who came late took the cloze but not the Nelson-Denny.

If we compare the first trimester students who took the cloze and not the Nelson-Denny, we see that most of them scored low on the cloze. From this we might surmise that they would have been low on the Nelson-Denny as well, and would have lowered the class average on the Nelson-Denny. The opposite occurred in the fourth trimester students where the only person not to take the Nelson-Denny scored higher than average and might reasonably be assumed to have raised the class average on the Nelson-Denny had he taken it. Thus the stated levels on the Nelson-Denny should be taken as indicative, not absolute.

The Nelson-Denny vocabulary test scores for the first trimester students exceeded their comprehension scores by 0.8 grade level while the fourth trimester classes exceeded their comprehension scores by approximately one and a half grade levels. This is not surprising, because the vocabulary test is a recognition test of discrete words whereas the comprehension test demands a certain amount of academic knowledge as background for the reading selections. In order to understand the distinction between recognition testing of vocabulary and the analytical/inferential testing of comprehension, it must be noted that there are two quite different skills involved. One must understand a majority of the words in order to comprehend a passage, but the inferential skills needed to understand a passage are not needed in recognizing individual words. As an example, in testing, multiple choice answers for vocabulary need only be recognized and answered; in the comprehension section a student must read the passage and analytically make inferences and only then search for the correct answer.

ARCHITECTURAL
DRAFTING

SS	TIME AT T-VI	N-D VOC	N-D COMP	N-D TOT	EASY CLOZE EXACT	EASY CLOZE APP	HARD CLOZE EXACT	HARD CLOZE APP
1.	1	15.0	15.0	15.0	71	95	45	84
2.	1	15.0	14.1	14.7	66	88	31	63
3.	1	14.6	14.7	14.5	57	68	23	34
4.	1	15.0	10.8	14.4	53	88	41	63
5.	1	14.0	14.7	14.2	73	88	46	84
6.	1	14.0	14.7	14.2	70	88	41	72
7.	1	15.0	11.5	14.0	64	84	48	80
8.	1	15.0	12.2	13.9				
9.	1	14.3	13.2	13.6	71	80	31	75
10.	1	14.6	12.2	13.6	64	90	34	68
11.	1	13.1	10.8	12.1	71	90	33	56
12.	1	12.4	10.0	11.3				
13.	1	10.1	10.8	10.4	57	73		
14.	1	9.6	7.5	8.5				
15.	1	9.2	7.0	7.9	64	80	18	56
16.	1				57	82	31	45
17.	1				55	66	16	28
18.	1				55	62	14	22
19.	1				53	62	38	46
20.	1				57	75	13	25
Average 1st Tri		13.4	12.6	12.8	62.2	79.9	31.4	56.3
21.	4	15.0	13.5	14.5	44	84	33	75
22.	4	13.9	11.5	13.0	80	95	41	75
23.	4	12.0	12.2	12.1	59	71		
24.	4	12.7	8.1	10.4	66	82	31	67
25.	4	9.2	9.3	9.3	51	82	28	46
26.	4				66	93	45	88
Average 4th Tri		12.6	10.9	11.9	61.0	84.5	35.6	70.2

Cloze Test Results

The cloze tests have provided key data with regard to the reading abilities of the students tested as well as for the appropriateness of material for the course structure overall. As previously noted, researchers in the past have found that results of cloze tests graded by demanding the exact word and tests graded by accepting synonyms showed almost exactly the same results. In this study, that was not the case for the cloze tests over technical material given to T-VI students. In general, there was a 25.4 percent point difference between the results graded by the exact word method versus the appropriate word method.

The initial cloze test was deliberately set at a very easy level for the students for two reasons. The first was to give the students confidence in a testing procedure which was unfamiliar to practically all of them. The second was to see if they would be able to score at an independent level as they should have, given their scores on the Nelson-Denny test. The first cloze selection came from Carpentry Fundamentals, a first trimester textbook (overall readability of 6.4) with which all the students should have been at least nominally familiar. The readability level for this cloze selection tested at a Dale-Chall 7.5, Fry 4, Raygor 5, and Flesch below 7, for average of approximately 5.9 level. Because a ninth-to-tenth grade reading ability was assumed for these students, it was decided that one easy

cloze and one difficult should show a range as well as take into account those students who would be at the extreme ends of that range.

The first cloze affirmed the original assumptions. The overall average for the first trimester students was an average 62.2 percent correct response on the exact grading while the fourth trimester students averaged 61.0 percent correct. Using appropriate word grading, the first trimester students averaged 79.9 percent correct and the fourth trimester group averaged 84.5 percent correct. All of these scores are well above the 57 percent needed for independent reading. These results confirmed that students with an average 12.4 combined reading level on the Nelson-Denny could read a sixth grade cloze test with ease.

The second cloze test, taken from job-related material, was at a college graduate level as measured by the readability formulas: Dale-Chall, college graduate; Fry 16; Raygor, scientific, professional, or technical; and Flesch, college senior. Given this level of difficulty, it was assumed that some of the students would be able to read it and the majority would be unable to comprehend this material adequately. The results contradicted these assumptions, especially for the students who scored low on the Nelson-Denny.

Using the appropriate word grading, the first trimester students scored 56.3 percent (at the high end of the

instructional reading range) while the fourth trimester students scored 70.2 percent (well into the independent reading range). For exact grading, the first trimester was at 31.4 percent correct compared to the fourth trimester score of 35.6 percent.

Two points were of immediate interest: The first trimester students were able to read college graduate material if one counts appropriate words as correct, and the fourth trimester students were 14 percentage points ahead of the first trimester in this response, seeming to indicate that they had a greater grasp of the overall material with their greater experience in the field. Neither group scored well in exact grading although some individuals were in the instructional reading material range.

A comparison of the Nelson-Denny results with the cloze results indicates the different orientations of the tests and the students. The Nelson-Denny, a valid academic test, is not necessarily the most appropriate test for T-VI students. On the other hand, the Nelson-Denny scores correlated highly with the speed with which the students were able to do the cloze test; the higher the Nelson-Denny score, the faster the cloze test was finished. Overall, it is apparent that while students with high scores on the Nelson-Denny also received high scores on the cloze, students with low scores on the Nelson-Denny did not necessarily receive low scores on the cloze test.

It appears that some of the students who score poorly on the Nelson-Denny Reading Test are in fact able to do well in reading when they are interested in the subject matter and have some backgound in the subject area. Several examples are readily apparent from the list of scores. The student who scored lowest in the first trimester on the Nelson-Denny had a 8.2 vocabulary, a 7.0 comprehension, and a 7.9 overall reading level. If presented with these results, one would have to make the assumption that the student would be unable to read technical material at all, let alone at a reasonable level. The same student scored 56 percent correct on the second cloze test using appropriate word grading, indicating a good level of comprehension. Likewise in the fourth trimester class, the lowest scoring student, with an overall reading level of 9.3 on Nelson-Denny, scored 46 percent correct on the appropriate word grading on the second cloze. Similar patterns hold for the students in Office Occupations, Diesel Mechanics and Nurse Assistants in Health Occupations as well and might be noted for comparison.

INTERVIEW FINDINGS

For ease of presentation, the interview results have been divided into three parts: reading, writing and suggestions. While writing was not an original part of the proposal for this study, it seemed apparent that there is a relationship between reading and writing in the job setting,

and it would be appropriate to examine the relationship as it might shed light on the central question of the study.

The interview questionnaire, Appendix B, was arranged in hierarchical form with regard to both reading and writing skills. As the interview progressed, it moved from reading to writing and finally to an open-ended, question-answer period when the interviewee could make suggestions as to what was good about T-VI training as well as what needed improvement.

In Architectural Drafting, the results of the interviews provided great diversity of response. The most common reading tasks described were those difficult to assess: reading blueprints, engineering notes, and interpreting survey maps. Other tasks included reading the code books and manuals and checking blueprints against allowable specifications in the Uniform Building Code and associated reference books.

The types of reading tasks are only one part of the research problem, however; the other part is determining the cognitive level at which the reading must take place. For analyzing this question, the questionnaire was organized according to Bloom's Taxonomy of the Cognitive Domain. The simplest level requires only recognition of information. The second level is comprehension which means responding to the information recognized in the first part. These two levels were combined into the question about whether the

person needed to understand information. All agreed that a person in Architectural Drafting had to understand reading material on the job, just as all agreed that the employee must "apply" that information which is the next level in the hierarchy.

Evaluation is the highest level in the hierarchy, as one must analyze and synthesize to be able to evaluate. Not all the interviewees said that their entry-level people had to evaluate information--that was reserved for people further up the line. However, those who said that a drafter did not need to evaluate information agreed that he must be able to ask questions about different parts of the drawing if there seemed to be discrepancies. This is an indirect affirmation that the drafter must be able to interpret information and make judgments. Thus while all did not directly state that evaluation was necessary, the implication was there.

The interview questionnaire also involved another level and asked if the entry-level person had to make decisions, and if so, whether they were monitored or unmonitored by superiors within the firm. Six said that drafters had to make monitored decisions based on reading, three said that unmonitored decisions were made. It was assumed that in training, a person received far more support and would be far more closely monitored than on the job. Due to the nature of drafting, everyone at the entry-level is working

with a team on a project and, as a junior member of the team, has constant contact with the other members. Thus whenever a question arises with regard to reading or drawing or an interpretation involving both, there is help at hand. It was noted independently by two people (Warren Shaw, office manager at Claudio Vigil, Architects; and Keith Carpenter, drafting coordinator at Uhl and Lopez) that one of the marks of a good entry-level person is the ability to know when to ask questions instead of making an uninformed decision.

The T-VI Drafting program appears to use the same books as those needed in entry-level positions according to Dale Heppler, head draftsman at Engineering Asociates, and Barbara Chavis, a junior drafter at the same firm, who stated, "reading materials that T-VI doesn't have, aren't entry-level."

Writing

Based on the interview results, writing does not appear to be a necessary prerequisite for being a good drafter. At the entry-level, writing is largely confined to writing notes on specifications sheets and notes on drawings with very little contact within or outside the office in writing. A point that a number of people made, however, was that writing makes the difference in advancement beyond entry-level. As an example, the Claudio Vigil office holds

writing seminars for all employees beyond basic drafters. Anyone who has contact with other architectural firms, engineering firms, or clients is strongly urged to attend the seminars because the firm realizes that their employees represent the firm. They want to leave a good impression.

Suggestions from Interviews

The suggestions are in two areas: abstract curricular needs and specific skills. The first area was well summed up by Warren Shaw of Claudio Vigil Architects, who said two things: Entry-level people need "real-world office knowledge" and that "T-VI can train for more than entry-level." He also said the occupation is "more than 'hey, draw this'--it's understanding the process to 'see' the drawing." This last comment about visualization was echoed by Heppler and Chavis.

The other general need was mentioned by Keith Carpenter and Emerson Begay, a computer drafter, that T-VI needs to stress computer-assisted-drafting (CAD) with the associated keyboard and manipulative skills needed for CAD work. Three drafters mentioned that there was enough architectural preparation at T-VI but that they felt inadequate when dealing with mechanical and electrical drawings. Keith Carpenter summed up this feeling in speaking of his company: "They were patient with me."

The specific requests look like an entire curriculum. They believe that T-VI needs:

1. electrical and engineering work
2. more residential truss work
3. more code book familiarity
4. computer design work
5. technical writing
6. more welding
7. more math
8. a day spent with T-VI housebuilders to see the process of building firsthand.

Overall, however, Shaw summed up the feelings of employers and employees alike in saying that his company is "happy with T-VI."

IMPLICATIONS FOR READING

Students in Architectural Drafting read in a variety of settings and for a variety of purposes. They must be able to read broadly and with depth of understanding whether it is reading engineering books to figure truss loads, reading a computer book to operate the CAD system, or checking final drawing specifications against those allowable in code books.

Clearly reading is critical in Architectural Drafting but the explicit teaching of reading would probably not be

worthwhile in an already crowded curriculum. However, integrating reading skill work into the regular curriculum could facilitate content instruction as well as improve the students' reading. While this could occur at any level of content instruction or reading level, the example drawn will deal with the question of reference and "seeing" at an intermediate level.

Such "outside" skills as reference work are really integral to a drafter being able to function properly. Use of the code books demands reference skills, but explicit exercises in finding material in them not only is boring, looking as it does like dictionary work in school, but does not use the code books as they were designed to be used. By giving students a more realistic use of code books, they become more aware of the number of interlocking systems present in any design.

Initial reading exercises to help the presentation of content material with the associated reading skills would precede this exercise which works with the integrative ability needed in the final justification of a drawing against allowable specifications. Because this exercise demands that students be aware of code book basic usage as well as a certain level of reference ability, teachers should introduce this exercise sequentially, beginning with easy examples and progressing to more difficult.

At the lowest level, the students would have a commercial design which might or might not be completely in accord with the Uniform Building Code (having to check a single drawing against specs could be an earlier exercise, leading to the skills involved in this). They would then be given an electrical schematic (certainly basic at first) and have to be able to check that for correctness within the entirety of the proposed building design. In order to do this they would have to be able to check the appropriate code books for specs and tolerances for each aspect individually and then see if they meshed as a whole, i.e., make sure that a conduit is not coming out of the central office at the seven and a half foot level or that there is a code violation.

Being integrative, each of the individual skills should be mastered first unless the teacher wanted to teach the material in a holistic fashion from the beginning. This exercise works as an individual or group activity depending on the availability of suitably graded materials and the desires of the teacher.

There is no need for this sort of simulation exercise to be isolated from other teaching because it can become an on-going exercise as the various systems of a building are added. Structural, electrical, plumbing, and heating and air conditioning considerations can all be subject to change, just as they are in the real world.

RESULTS: OFFICE OCCUPATIONS

The results of the Office Occupations Study will be presented in four parts: readability of materials, testing results, interview data, and implications for reading in Office Occupations

READABILITY RESULTS

Text Readability Findings

The results of the text study are based upon the application of readability formulas to samples taken from the texts that the students use for training at T-VI. The books ranged in difficulty from grade level 11.6 to 16.8 with an average for the eight books of 13.9. The average of the 27 samples was somewhat higher at 14.3. The books are listed in ascending order of difficulty:

Managing Today and Tomorrow ---------- 11.6
College English and Communication ----- 12.6
The Career Legal Secretary ---------- 12.8
Introduction to Data Processing-------- 13.2
Fundamental Accounting Principles ----- 13.5
Principles of Marketing ---------- 13.5
Intermediate Accounting ---------- 16.4
Medical Office Handbook ---------- 16.8

Overall, the text samples tested out at Dale-Chall 14.4; Fry 13.9; Raygor 14.6 and Flesch 14.2 for an average of 14.3 for all scores of all samples.

Technical Word Deletion

In addition to the regular readability tests, technical words were replaced with a single syllable, five letter word to try to prevent skewing. For Office Occupations there were only three samples where this procedure was applicable. These samples all were written in legal language. Without deletions the samples tested at 15.3; with deletions they tested at 13.5, a drop of 1.8 grade levels.

For purposes of deletion, technical words were defined as those which were specific to the occupation, i.e., words that one had to know in a given context within the profession. As an example, in an intermediate accounting book, one passage uses the expression, "the flow-through method of accounting." Clearly this is a technical word as it has a specific meaning within accounting--one that the reader has to know as there are no contextual clues.

While the drop in readability level appears large, it may not be significant as students appear to be able to read material that tests above their reading level as measured by standardized tests when one uses cloze tests.

Job Materials

The reading materials from the workplace were collected during interviews with area employers and employees. The materials ranged in difficulty from 9.8 for a description of sick leave in an office policy handbook to graduate school level for legal documents and medical insurance forms. Where the Office Occupations textbooks were difficult at a 14.3 reading level, the job materials were somewhat more difficult at grade level 15.0 for the eleven samples analyzed. Of eleven samples, three were suitable for technical word deletion. The change was from a level of 15.8 down to 13.9 reading level.

The workplace materials are listed in order of difficulty:

Fund-raising thank you letter from the Roman Catholic Archidiocese ---------- 12.6
Employment guide from an Albuquerque law firm 13.3
Brochure from the Roman Catholic Archdiocese - 13.5
Trust agreement from a bank ---------- 15.0
Trust agreement ---------- 15.0
Medicare payment release form ---------- 16.0
Trust payment document ---------- 16.0
Guidelines for Legal Assistant Services ----- 16.0

In addition there were six types of medical forms which were not suitable to be tested by the readability formulas.

TESTING RESULTS

Nelson-Denny Reading Test

In interpreting the results of the Office Occupations students on the Nelson-Denny, it should be noted that two first trimester students scored at the highest level--at 15+ grade level overall--while one was below sixth grade, the lowest level of the Nelson-Denny Test. The average score was an 11.0 reading level for the first trimester while the third trimester students scored a 10.4. In light of the standard error of measurement of roughly a grade level, there is little difference between the first and third trimester students. It is interesting to note that the third trimester students were very even in their results on the Nelson-Denny with the average of all three scores (vocabulary, comprehension, total) falling in the tenth grade level. The first trimester students were far more similar to the Architectural Drafting students in scoring in the twelfth grade level in vocabulary and tenth in comprehension for an eleventh grade overall reading level. One possible explanation for the balanced scoring of the third trimester students is that they have become better general readers through their study of office skills with a training which by nature must be generalized, rather than specifically technical. Thus while their total score is not better, the comprehension measure indicates a broader reading skill. Doug Swift, Chairman of the Department of

OFFICE
OCCUPATIONS

	TIME AT T-VI	N-D	N-D COMP	N-D TOT	EASY CLOZE EXACT	EASY CLOZE APP	HARD CLOZE EXACT	HARD CLOZE APP
1.	1	15.0	15.0	15.0	54	93	55	94
2.	1	15.0	13.2	15.0	58	97	53	90
3.	1	14.8	13.5	14.1	54	88	74	94
4.	1	15.0	9.3	14.0	47	84	55	77
5.	1	13.1	11.5	12.5	58	97	61	92
6.	1	11.4	11.5	11.5	40	83	35	55
7.	1	9.6	7.0	8.1	43	83	64	74
8.	1	9.2	6.3	7.1				
9	1	11.1	BELOW	6.6	40	83	42	53
	1		SIXTH					
10.	1	8.6	6.0	6.4	24	38		
11.	1	8.3	BELOW	BELOW	29	45		
1st Tri. AVERAGE		11.9	10.4	11.0	44.7	79.1	54.9	78.6
12.	3	13.6	14.4	13.9	50	84	59	98
13.	3	14.8	10.8	13.4	56	77	66	87
14.	3	10.9	8.7	9.7	58	88	57	87
15.	3	9.2	8.7	8.9	62	87	33	40
16.	3	7.5	10.8	8.8				
17.	3	8.6	7.0	7.5	31	54	24	48
18.	3				58	83	59	87
3rd Tri AVERAGE		10.8	10.1	10.4	52.5	78.8	49.7	74.5

Developmental Studies, indicated that the attrition rate in Office Occupations meant that the better students were left in the third trimester.

An interesting aspect of the Nelson-Denny Test scores is that the Office Occupations students break into two very clear groups: those who score 9th grade or below, and those who score 11th grade and above. There are no tenth grade readers of the students tested. Of the third trimester students, four of six are below tenth grade while in the first trimester, five of eleven are below. On the face of it, one would conclude that neither of the low groups could successfully read material in the texts, let alone materials from the workplace. This is where the cloze tests prove invaluable.

Cloze Test Results

As noted previously, cloze tests were constructed from samples of Office Occupation reading materials in order to measure the appropriateness of given material for students. The students took two tests, one easy as an introduction (at the 7.5 reading level) and one difficult (at the 16.8 level). The first passage selected for the cloze tests was taken from a text, Introduction to Data Processing, while the other passage came from the policy handbook of a large law firm in Albuquerque.

By taking one easy and one difficult passage, a wide range of scores was assured. Such proved to be the case, but these tests also revealed that the lower scorers on the Nelson-Denny achieved higher-than-expected scores on the cloze tests. On the first cloze, both groups of students got 78.8 or more percent correct using appropriate word grading as compared to 44.7 percent for the first trimester students and 52.5 percent correct for the third trimester group when using exact grading. These high scores were to be expected, as the cloze passage tested at a low 8.1 readability level. Combining both sections, all but three students tested at an independent reading level for this cloze. Of those three students who scored below the independent level (over 57 percent), two were at least at the instructional level(44-57 percent), even though the

Nelson-Denny scores indicated a sixth grade reading ability for all three.

On the second cloze test (workplace materials), the results confirm the trend of low students on the Nelson-Denny being able to read above that level. Overall, third trimester students scored 74.5 percent correct against 78.6 percent correct for the first trimester group using appropriate word grading. The difference is in part explainable because the bottom two students in the first trimester did not take the second cloze, which raised the overall average. On exact grading, the first trimester students scored 54.9 percent correct compared to a 49.7 percent correct for the third trimester students. That the good students did well on the cloze is not surprising, but it is worth noting when the results of the students at the lower end of the Nelson-Denny grouping did well on a test that was scaled at the college graduate level.

Of those students who scored below tenth grade level on the Nelson-Denny, three in the third trimester and two in the first trimester, the average appropriate word grading score was 60.4 percent while the exact grading was 44 percent correct. That meant that overall, students with an eighth grade reading level could read graduate school material with good comprehension. This appears to be a real anomaly, but the same phenomenon occurred in the Architectural Drafting students. Just as in Architectural

Drafting, the explanation seems to lie in the lower general knowledge background of the students in contrast to their superior knowledge of their chosen occupational field.

INTERVIEW FINDINGS

The interview results will be presented in three parts: reading, writing and suggestions. While the main purpose of the study was to determine the readability of materials in training and on the job as compared to the student's reading level, it was believed that a determination of writing demands on the job could shed additional light on the original question.

The interview questionnaire revealed that letters and memos were the most common materials read. Mention was made of reports, reading from computer terminals and accompanying computer documentation, business forms, and manuals. Of these materials, the technical aspect of language--specifically the vocabulary--was believed to be the most difficult part. As one woman noted, "I have to look up penicillin every time I spell it." Other responses included having to look up words on the different types of insurance forms as well.

As to the cognitive level of reading that must be done, a form was developed roughly based on Bloom's Taxonomy but here using only four levels: understanding (passive comprehension), application (using the information for some

other purpose), evaluation (having to make a judgment based on the information), and finally decision (not included in Bloom's work, but having the person actually make a change based on the information read). The questions related to decision-making distinguished between monitored and unmonitored decisions. Using this classification scheme, interviewees agreed that people had to understand and apply reading information, but only three of eight indicated that evaluation came into play. Five people indicated that monitored decisions occurred, but only one included unmonitored decision-making ability. A cursory glance at this information points out a discrepancy in that five people made decisions but only three used evaluation. While seeming to indicate that two people made thoughtless decisions, in fact, it represents two people who had a procedural checklist and thus just applied information to the checklist rather than formally evaluating it. While not analytic evaluation, this applicative evaluation still represents a judgment.

The writing component of Office Occupations shows time is spent on reports and forms. The question of what was most difficult brought interesting responses. Some people thought the technical aspect of writing was harder while others found general English to be the problem. The same pattern held in the response to the question about whether reading or writing was harder. One interviewee said writing was easier because, "Reading has to be understood; I know

what I'm writing about." Another said writing was more difficult because, "you have to explain the problem in concise medical terms to an insurance company, and that's hard." She felt that it was technical vocabulary and general English that was her problem. She felt she had writing problems compounded by technical vocabulary. This contrasts with the woman who was to replace her who said, "I can write letters fine, but only if I know the terms." For one person, reading was more difficult than writing because of the legal nature of the trust instruments. Another found the technical writing more difficult because she felt competent to write letters, but not to fill in all the insurance forms that come to the trust department. By her accounts, she had lots of general writing at T-VI, but no legal work.

Finally, the suggestions were varied, as might be expected. The suggestions are listed:

1. More word processing (5)
2. Computer billing (2)
3. Insurance form instruction (3)
4. Legal instruction (1)
5. Tax instruction (1)
6. More writing (1)
7. Dictaphone tapes like the real world (1)

The last request came because a secretary had a boss who chewed tobacco and his enunciation was not clear,

especially when he had his boots on the desk and was a long way from the microphone when he spoke.

Thus the interviews served to show what several levels of people within Office Occupations saw as necessity. It also showed what a diversity of jobs are available within the one occupation and how training has to be general for the group or completely fractured into each specific job type which would be limiting for the graduates.

IMPLICATIONS FOR READING IN OFFICE OCCUPATIONS

Training for Office Occupations has to be generalized if a track system is to be avoided with its incumbent narrow focus. The implication for reading in generalized training is that the students must learn strategies and activities common to most offices rather than focus on the forms, vocabulary and methods of one specialized field such as law, medicine, architecture or distributing. Under strategies might be listed the knowledge of how to get needed information such as travel, personnel, or service data while activities would be the actual use of that data.

To practice these skills one might set up a simulation lab in which students would receive information in the form of a memo and have to respond in the appropriate fashion. At first this could be a small group activity in order to use the combined resources of several people. Later, it could be

individual. Several levels of simulation could be set up depending on the level of the students; thus, one group might simply have to show how to get certain information while others might have to carry out the process.

Exercise:

In memo form students are requested to find out information for the boss. Some of the common areas:

1. Travel information: getting plane, car and hotel reservations for certain days and times.

2. Calling temporary agencies and arranging for additional personnel (type of personnel could be specified).

3. Calling the printer/paper company to get more letterhead stationary or labels.

4. Getting the copy machine serviced--could be either repair or normal maintenance--toner, paper etc.

5. Office supplies--getting information on prices, delivery, and other service.

6. Office machine maintenance--typewriters, dictaphones, postage meters, coffee machines and any specialty equipment.

7. Getting messages from the answering service and leaving instructions for forwarding.

8. Making restaurant reservations and arrangements.

9. Setting up a pick-up with Federal Express, Emory or another air freighter.

For each of these activities the teacher must specify how detailed the information must be, i.e., are students to call an airline and find out the cheapest or most convenient flight to Kansas City on Tuesday after 11:30, or will they just have to show the procedure for finding the information, listing the probable sequence?

While this may seem an exercise in the Yellow Pages, it demands somewhat more underneath. In the above example, a secretary has an immediate choice of calling a variety of airlines and comparing price vs. convenience or calling a travel agency and getting the specifications. With a travel agency, discounts are available if a client is a frequent user--is this applicable or would another agency give a better deal? What about the return trip?

Not only will such exercises make students more aware of the types of information resources available, but they will also bring some of the reality of the office into training.

RESULTS: DIESEL MECHANICS

Results of the study will be presented in four parts: readability levels, tests results, interview data, and implications for reading in Diesel Mechanics.

READABILITY RESULTS

Readability of Text materials

The reading materials tested for diesel fell into three groups: the text materials, the field materials and materials which are used in both areas. Books such as Practical Physics are purely textbooks, the Detroit Diesel V-71 Manual is a job repair manual while the John Deere Air Conditioning Manual is both. Readability levels ranged from high school to college level. Here is a list of the books used in Diesel Mechanics as measured by the four readability measures:

Mathematics for TVS	9.6
Practical Physics	10.3
Electrical Systems	10.3
John Deere AC	10.9
John Deere ID	11.8
Diesel Mechanics	12.3
Engineering Drawing	12.3
Diesel Engine Repair	12.8
Diesel Equipment I	13.2
Diesel Equipment II	14.3

Job Materials

The job materials read in diesel mechanics are repair manuals and parts books and, to a lesser extent, insurance and warranty information. By and large, entry-level mechanics are not allowed to do the insurance and warranty work on their own. The price for voiding a warranty or misfiling a piece of insurance work is simply too great for shops to take a chance. The entry-level worker, therefore, will take care of the mechanical work and pass the paperwork on to the foreman for a check of the job and filling out the forms.

The entry-level mechanic will have to use the repair manuals and parts books on a daily basis. While the parts books do not lend themselves to readability analysis because the noncontinuous nature of the writing, as a task they represent only use of reading at the recall level, i.e., the mechanic notes the part, the brand-name, year and model and then records the replacement part number for the parts department. On the other hand, the use of the repair manuals demands higher level reading skills as the mechanic analyzes the problem and evaluates the condition of the part against the allowable specfications. On the basis of this synthesis, repair action is taken.

The repair manuals used in diesel mechanics have a very straight-forward organizational pattern. Just as the systems of a truck are discrete and not linked (other than by the frame), so the parts of a manual are not linked other than by the binding. The only connection between the starter motor and the brakes is that they are mounted on the same frame. Furthermore, the pattern is from larger-to-smaller in each unit. Manuals begin with an overall physical, functional, and operational description of the unit and proceed to subdivide, with each subunit following the same pattern of top-down classification. The isolation of each system from the others allows repair to proceed in a logical sequence organized by trouble-shooting procedure. "If the engine turns, but does not start, turn to page..." "If the engine starts but dies quickly, turn to page..." The implications of such organization will be considered in the summary.

The readability level of the job materials is based upon manuals from the major diesel engine manufactors. As previously noted, parts books do not lend themselves to readability levels, a trait shared by insurance and warranty notices. The job reading scores are:

Catepillar Diesel	9.6
Cummins Diesel 855	11.3
Detroit V-71	14.3

TESTING RESULTS

Nelson-Denny Results

The Nelson-Denny Reading Test was given to two groups of diesel students. The first trimester students averaged 11.1 grade level as a combined score while the fourth trimester students combined for 10.3. While this pattern of scores appears backward, it must be noted that the lowest scores in either group come from the fourth trimester by two students, one of whom is known to be dyslexic and the other suspected. As the Nelson-Denny is a speed test with a premium on quick recognition and execution of answer, people with diagnosed reading problems are at a distinct disadvantage. Dropping those scores, the fourth trimester is at grade 11.3, virtually the same as the first trimester.

Several other patterns emerge from looking at the results: there are no 9th or 11th grade readers and the two trimesters are evenly split in the 12th grade and above and 8th grade and below groups. In both groups the vocabulary scores exceeded the comprehension scores. While this is the pattern found in Office Occupations and Architectural Drafting as well as by Sherrill in vocational students in Missouri, it is not typical of the Nelson-Denny as normed.

DIESEL MECHANICS

	TIME AT T-VI	N-D VOCAB	N-D COMP	N-D TOTAL	TECH EXACT	TECH APP	BLOOM COMP TEST
1.	1	15.0	15.0	15.0	49	88	10.0
2.	1	15.0	15.0	15.0	56	80	10.0
3.	1	15.0	8.7	14.0	21	49	1.0
4.	1	14.8	8.7	13.0	51	78	8.5
5.	1	13.6	10.0	12.3	47	78	9.0
6.	1	13.9	8.7	12.0	47	72	7.0
7.	1	10.5	10.8	10.6	41	72	9.0
8.	1	10.5	6.6	8.1	29	60	6.0
9.	1	8.1	8.1	7.9	47	66	4.5
10.	1	8.6	7.0	7.5	21	58	3.0
11	1	7.9	7.0	6.9	25	39	4.0
1ST TRI. AVERAGE		12.1	9.6	11.1	39.8	67.7	6.5
12.	4	14.8	12.2	13.7	66	98	10.0
13.	4	13.1	13.5	13.2	37	72	6.5
14.	4	13.1	12.8	12.9	47	88	7.5
15	4	14.0	10.8	12.9	43	62	6.0
16.	4	13.9	9.3	12.3	58	78	9.0
17.	4	12.9	10.8	12.0	60	80	7.0
18.	4	13.8	6.3	10.0	25	39	7.0
19.	4	8.9	8.7	8.8	64	98	10.0
20.	4	7.7	6.3	6.0	47	82	4.0
4th Tri Subtotal		12.5	10.1	11.3	50.1	77.7	7.4
21.	4	7.7	6BELOW	6	43	64	6.0
22.	4	7.3	BELOW 6	BELOW 6	29	58	8.0
4TH TRI. AVERAGE		11.6	*9.3	*10.3	47.6	74.8	7.4

*Extrapolated score using a grade of 5.5 for the lowest two scores--those below grade six.

Cloze Test Results

The cloze tests provided quite different information from the Nelson-Denny, as might be expected. With exact grading, the first trimester students scored 39.8 percent correct compared to 47.6 percent for the fourth trimester for a passage with a readability level of 14.3. Under conventional thought this means that the material is too difficult for the first trimester students but in the instructional range for the fourth trimester students. However, when appropriate word grading is used the first trimester students score 67.7 percent correct against 74.8 percent for the fourth trimester, both scores well into the independent reading range.

The difference between first and fourth trimester remained even with a 7.8 percent difference between exact grading and a 7.1 difference for appropriate word grading. The 27 percentage point discrepancy between exact and appropriate word grading for both first and fourth trimester students would appear to be explained by the redundancy inherent in technical writing and will be discussed in the conclusion. The seven percentage point difference between the groups however appears to be a difference in the experience of the two groups related to the length of time spent in training.

Of those students who scored below 10th grade on the Nelson-Denny, all but one scored at the independent reading range (57%+) by appropriate word grading for a passage which had a readability of 14.3 grade level. The effect of training is more clearly demonstrated on the Nelson-Denny low scorers: fourth trimester students under 10th grade got 76 percent on the cloze while first trimester students received a 56 percent, a much greater discrepancy than for the overall training effect (20 percentage points vs. 7 points).

Comprehension Test

The comprehension test was taken directly from the passage used in the cloze test, with the students receiving a complete copy with all the words. The test itself was hierarchical in nature, being based on Bloom's Taxonomy of the cognitive domain. Thus, the questions were structured to demand that the higher cognitive functions (analysis, synthesis and evaluation) came at the end of the test while lower functions (knowledge, comprehension, and application) were at the beginning. Following the pattern of the cloze test and reflecting training knowledge, the fourth trimester students scored 7.4 out of 12 questions, compared to 6.5 for the first trimester.

Observations on Results

There are two observations on the results that bear notice: there appears to be a culture/language bias; a low score on the Nelson-Denny does not mean a low score on the cloze or comprehension test; and that through training a person can read materials much more difficult than standardized tests show they should be able to read.

Of the eight lowest scores on the Nelson-Denny test (those below 10th grade), six are not anglo, according to a self-report. When one of the anglos is known to be dyslexic and the other is probable, the figures appear even more stark. Essentially, this simply shows the obvious--that if one grows up not sharing anglo culture as measured by an anglo college-oriented reading test, then one will not score well. However, and this is worth note, this bias is not reflected in the cloze and comprehension section.

The figures from the cloze do not show the same pattern because much of what the cloze is measuring is learned in technical training and not from outside experience. That is the cloze and comprehension tests are, to a greater extent, measuring reading within the occupation, rather than reading in general. Where the four lowest scoring students from first trimester had a Nelson-Denny of 7.6, the lowest fourth trimester students were at a 6.5. The latter score is derived by extrapolating a 5.5 score for the two students who did not make the 6th grade scoring floor. These

students who would be considered minimally literate, however, were able to score 56 percent correct and 76 percent correct on the cloze for the first and fourth trimesters respectively, not only comprehending the sense of the discourse, but scoring almost at the independent range for the first trimester and well into the independent range for the fourth trimester students (actually higher than the fourth trimester as a whole). This reflects not only the experience factor (here 13 percent difference compared to seven percent overall), but also the fact that the cloze is a power test rather than a speed test. Poorer readers can get through material, it just takes longer. The Nelson-Denny does not allow a person time where the cloze does.

On the comprehension test, the lower students in the fourth trimester scored 7 of 10 compared to 4.4 for the first trimester. Seventy percent correct appears to reflect not only the training of the fourth year students but also the time the students had to do the test. Forty-four percent shows the difficulty of the passage for those who were unfamiliar with the material in training.

The impact of students reading more ably within their occupations than their ability shows as measured by standardized tests is that less able readers can become competent within the occupation, but may need a little more time and/or support to achieve the proper level. This is not

to support an abandoning of standards, but only to say that the lowest four scorers in fourth trimester (those below 10th grade on the Nelson-Denny) all were in the independent reading range on the cloze with appropriate grading.

INTERVIEW RESULTS

The interview results will be presented in three parts: reading, writing, and suggestions.

It is no surprise that the most commonly read items on the job are diesel manuals and parts books. While there was no indication of an inability to read these, in particular the manuals, several mechanics noted, "the toughest part is the big words" with one specifying that it is the words, not the ideas behind the words. Others noted that parts are increasingly being read on microfiche and that the part number is being orally delivered to the parts department. Other reading was checklist procedural reading, for example the 10,000 mile check on the Michelob fleet at Sunland International and warranty and insurance form reading.

The most common reading problem in making technical repairs according to mechanics and supervisors alike is in electronics. The problem takes several different forms. The most directly stated is the problem of troubleshooting electronics parts. Several of the mechanics said they wished they had had more training in electronics so they could know what they were doing in reading troubleshooting protocols.

Where a needle probe or multimeter with alligator clips used to suffice for electrical testing, integrated circuit boards require sophisticated electronic testing equipment. This necessitates not only a knowledge of and an ability to read the manuals for the testing equipment, but also knowledge and reading skill in interpreting the results in a meaningful fashion for repairing the engine. One manager flatly stated, "We don't have blackbox equipment here... we just bypass." He went on to add that his company was going to a computerized system, moving away from paper, and that he was expecting problems in the use and acceptance of the new system.

Where electronics reading and repair work was the most cited technical reading problem, warranties and insurance reading was the reading most often noted as being problem reading by mechanics and managers. Along with the difficulty of this reading material must be added the thinking and writing component as they are inseparable at this point. Where reading a manual for performing a repair demands understanding of the material, the performance response is made in the repair. Insurance and warranty forms demand not only that the mechanic be able to do the repair but be able to write the "story", including what the problem is and why it happened, what needs to be done and why, what parts replaced and why, and the service call ticket with an estimate of the cost. For this reason, many shops have

foremen or service managers write up the paperwork as a mistake can be extremely costly. Of the mechanics who did do their own write-up, all passed the paperwork through a supervisor.

Writing

At this juncture, the problems of reading and writing come together. Where the reading of diesel manuals results in repair, the reading of warranties and insurance work results in writing. Thus, while a certain amount of writing is necessary at the entry-level, it is limited to writing requisitions and the "story" for warranty and insurance work: both in-house activities that are closely monitored. If a requisition is written wrong, either a part is not delivered or the wrong part is delivered, both of which bring immediate feedback to the writer. "Story" writing has a different sort of feedback as the supervisor checks the work against the written narrative of the work before giving final approval. Not only is the mechanical work checked, but also the ability of the mechanic to explain what was done. If the narrative and the repair work correlate, the supervisor can write up the warranty or insurance report; if the two do not correlate, the supervisor must go over the procedure with the mechanic.

Thus writing ability is one of the key factors in a floorman advancing to independent status (such as road repairs) let alone into a supervisory position, if he wants

such a position. As Gordon Whitely at Contractor's noted, "Not many want to get off the floor...they hate paperwork."

IMPLICATIONS FOR READING

The explicit teaching of reading in diesel courses should be avoided. That being stated, there are many ways in which reading instruction can be embedded into the course content for the benefit of the students and the ease of the teacher. One of the easiest and certainly one of the most useful skills needed in diesel mechanics is reference ability, whether it is used for parts indexing or finding the proper procedure in a manual.

Reference skills are basic for primary acquisition of knowledge as well as for constant use on the job, but it is usually taught academically as dictionary skills or library use (a sure way to lose the students if introduced as such). In fact reference skills apply within the text just as surely as they do outside the text. Here is a sample lesson for teaching reference skills in a way that helps introduce course material while aiding the students in their ability to see the organization of diesel manuals.

Exercise:

This could be used in virtually any introductory situation but would have to be walked through the first time to give the students confidence in their own ability.

The only teacher preparation is to put together a worksheet of the important points to be covered in a given unit with specific questions at the recognition and recall level (this is for introduction of material--not integration with the rest of the material they have learned). These questions serve as organizers for the student, not to test knowledge. They should therefore be easy and obvious enough to suit the appropriate level of the class. For the example, let's use Unit 3 of Diesel Mechanics One by Erich Schulz.

Sample Worksheet Questions
Directions to the student

Answer in one sentence:

1. What is the function of a seal?

2. The book classifies two types of seals. What are they?

3. Where are mechanical seals used? And O-ring seals?

4. What kind of seal is a gasket?

5. Name two kinds of gasket material.

6. Where can you find information on preventing sealing failure? Give the page number.

7. Liquid sealants can be useful. Name one use.

8. What page shows what liquid sealant to use for a specific purpose?

With these eight questions a student will have to look through the entire chapter. Most of the questions are cued to the boldfaces used as subheads, making him aware of the construction of a chapter without saying chapters are arranged in such and such a way. (Actually this arrangement information can be told to the class at the beginning, but it will be in exercises such as this that the student will internalize it.) The exercise is geared to having the students view the entire chapter as one unit while at the same time breaking the student habit of starting to read at the first word and trying to read every word straight through. The real point is getting students to realize that they can get the information more easily and thoroughly by skimming the table of contents, chapter, and bold faces/subheads rather than struggling word for word.

This sort of sheet could be given as homework or for the opening minutes of class and can be used individually or in a group. The point is to introduce the content material while gearing students to look for the organizational clues given in the text. The worksheet then becomes one basis for the teacher to lead class discussion and gives the student the reinforcement of having gotten through the text as well as something to keep from the class.

Note No. One: one part of this is that the teacher has to have confidence in the ability of the students to do the exercise. In the beginning, the students may need some help

from the teacher and, in addition, it may be better for the students to work in groups to allow the more able students to show the less able students how to do the work (if only by example). This demands that the teacher see himself as a facilitator rather than the sole authority and giver of information.

Note No. Two: Processes were ignored completely (installing Lip seals and O-rings, the question on preventing sealing failure, only asked for the page number). The details of processes are better dealt with in discussion where students can interact and question the teacher as to why--the only point of this exercise is introduction of basic organizational concepts and vocabulary and the way to find that information.

Note No. Three: After a few of these exercises, the students will become far more aware on their own of the structure of the text but a help at the beginning might be to show them that the usual format of a technical text is Introduction, a Functional Description, a Physical Description and then an Operational or Process Description which will contain any number of subcategories depending on the complexity of the subject. As students get better, the teacher can expand the exercise almost indefinitely for introductory use, or use it for summary or review.

RESULTS: HEALTH OCCUPATIONS

Results will be presented in four parts: readability levels, test results, interview data, and finally, implications of the data with regard to reading in the Health Occupations.

READABILITY RESULTS

Readability of Text Materials

The readability results come from texts used at T-VI and materials collected in the field. The difficulty ranged from 10th grade to college graduate with most books in the college range.

There were two types of texts. The first group was standard teaching texts while the second was reference books used both in class and on the job. An example of the first group would be a book such as The Nurse and the Childbearing Family which could be used as a reference later in a career but is designed for teaching. The Nurse's Drug Handbook, on the other hand, can be used in class to teach about types of drugs and their interactions, but was written as a reference work and not for consistent reading. The readability levels of health occupations materials is generally quite high, the exception being for Nursing Assistants. Both of these findings are in line with expectations.

Practical Nurse

Basic Nutrition and Diet	12.0
Essentials of Human Anatomy and Physiology	14.0
Human Anatomy and Physiology	14.8
Mental Health Concepts	15.0
The Fundamentals of Nursing	15.5
The Nurse and the Childbearing Family	15.8
Medical Surgical Nursing	16.5
The Nurse's Drug Handbook	16.9
	15.1

Respiratory Technician

Lab Exercises	13.3
Respiratory Therapy Equipment 2	13.4
Egan's Fundamentals of Respiratory Therapy	15.5
Respiration in Health and Disease	15.5
Respiratory Therapy Pharmacology	17.0
Clinical Pulminary Disease	17.0
Clinical Applications of Respiratory Care	17.0
Principles and Practice of Respiratory Therapy	17.0
	15.7

Nursing Assistant

Understanding Normal and Clinical Nutrition	10.1
Hospital Unit Secretary	11.8
Mosby's Textbook for Nursing Assistants	13.0
	11.6

RESULTS OF TESTING

The testing results are complex and will be reported for each of the occupations in the health sector. Overall the Respiratory Technicians scored at the 14.2 grade level on the Nelson-Denny while the Practical Nurses were at 14.1 and the Nursing Assistants were at 10.3.

Respiratory Technicians

This group had the best reading level of any group tested at T-VI as measured by the Nelson-Denny with a 14.2 grade level. Of the eleven people tested, four were over grade 15 which is the effective ceiling for the test. All of the others were at or over 12.5.

The cloze test results reflected the high level of the Nelson-Denny Reading Test results. The readability level of the cloze passage was grade 16. The passage described recent developments in home respiratory care, focusing on different types of oxygen enrichers and concentrators. As in the other occupations, the cloze was graded by both exact and appropriate word method. Overall the RTs scored 56.9 percent on the exact grading and 84.5 percent by the appropriate word method, showing good comprehension of the material. The 56.9 percent compares favorably with the independent reading level of 57 percent posited by general language research. In light of the scores on technical

passages registered by other occupations, 56.9 percent is very high. The 84.5 percent score with appropriate grading reflects the same high level as the exact score. The 28 percentage point discrepancy between the exact and appropriate grading methods is in line with the results of the other occupations.

The comprehension test results reflect the same superior reading ability as the two previous tests. This test correlated well with the Nelson-Denny as the top five scorers on the Nelson-Denny were also the top five scorers on the comprehension test while the bottom four on the Nelson-Denny were also the bottom four on the comprehension.

RESPIRATORY TECHNICIANS

	N-D VOC	N-D COMP	N-D TOT	CLOZE EXACT	CLOZE APP	COMP
1	15.0	15.0	15.0	67	93	12
2	15.0	15.0	15.0	67	88	12
3	15.0	15.0	15.0	63	91	12
4	15.0	11.5	15.0	58	84	12
5	14.5	15.0	14.6	44	77	12
6	15.0	11.5	14.0	55	82	11
7	15.0	11.5	13.9	58	91	12
8	14.9	12.2	13.8	58	90	11
9	15.0	9.3	13.4	49	77	11
10	14.6	12.8	13.4	51	79	10
11	13.1	11.5	12.5	49	77	10.5
Avg	14.7	12.8	14.2	56.9	84.5	11.4

Practical Nurse

The nurses were virtually at the level of the RTs with 12 of the 28 students scoring over the top on the Nelson-Denny and the class as a whole averaging 14.1. In keeping with the other groups tested, they did better on the vocabulary section than the reading comprehension part. With all the students having graduated from high school, the majority having had at least some college, and all having English as a home language, the results are not unexpected.

The cloze tests support the findings of the Nelson-Denny with the top and bottom scorers on the N-D roughly matching those on the cloze. The cloze passage had a much higher discrepancy between the exact and appropriate grading scores than for other occupations, largely, it appears, because of the compound adjectives in the passage describing drug dose scheduling. The use of complex adjective phrases means that it is difficult to pick the exact word, but somewhat easier to choose an appropriate word. For example, the passage used "drug," "painkiller," and "analgesic" almost interchangeably with the result that students knew the meaning of the passage and chose an appropriate word, but were unable to choose the exact word. Thus the discrepancy. Those with over 15 on the Nelson-Denny were in the 70-90 percent correct range on the cloze while most of those in the 13 grade level on the N-D scored in the 50-60 range.

PRACTICAL NURSE

	N-D VOC	N-D COMP	N-D TOT	CLOZE EXACT	CLOZE APP	COMP
1	15.0	15.0	15.0	38	89	12.0
2	15.0	15.0	15.0	32	83	9.6
3	15.0	14.4	15.0	23	78	6.0
4	15.0	15.0	15.0	36	90	10.0
5	15.0	14.4	15.0	23	69	7.5
6	15.0	15.0	15.0	30	80	8.8
7	15.0	14.4	15.0	20	72	9.5
8	15.0	15.0	15.0	27	85	10.0
9	15.0	14.7	15.0	25	65	9.0
10	15.0	14.1	15.0	25	72	8.3
11	15.0	14.7	15.0	32	94	9.5
12	15.0	14.1	15.0	18	90	10.0
13	15.0	13.5	14.6	27	81	11.0
14	14.9	13.8	14.3	23	65	9.8
15	14.4	14.1	14.1	23	65	3.0
16	14.3	13.8	13.9	32	77	8.0
17	14.8	12.8	13.9	12	47	8.8
18	14.9	12.2	13.8	30	69	7.3
19	14.2	13.5	13.7	21	69	8.3
20	13.6	10.8	13.6	21	72	5.3
21	13.3	14.1	13.6	23	67	6.0
22	14.3	12.2	13.3	21	54	7.0
23	13.8	12.8	13.2	16	50	6.3
24	14.5	10.8	13.2	36	89	9.3
25	13.5	12.8	13.1	16	67	9.8
26	10.5	14.4	12.8	27	81	9.5
27	13.6	11.5	12.8	21	52	6.0
28	12.9	8.7	10.9	20	44	4.5
AVG.	14.4	13.5	14.1	25.5	72.5	8.2

The hierachical comprehension test agreed with these results as well with the 15+ students in the 8-12 correct range out of twelve possible and the 13th grade level students in the 6-8 range. This would appear to indicate that the better readers on the N-D are better able to use their higher cognitive skills more fully than the others when presented with an unfamiliar reading passage.

Nursing Assistant

The nursing assistants present a very different group from the previous two. They are multiethnic, multilingual, of varied educational background and possess a great range of reading ability as witnessed by nine persons at or below the sixth grade reading level and eight above the 13th. The class average is a 10.3 grade level if one omits the bottom three scores which did not make the sixth grade. If one counts those scores as a fifth grade level, then the class average is a 9.9.

The cloze results add light to the Nelson-Denny results. On a passage at the 12th grade reading level, the 12th and 13th grade level students did well as might have been expected, but the students at the 8th and 9th grade levels did almost as well overall. It is not until one gets to those below sixth reading level that real problems are apparent. This would seem attributable to the effect of training in the subject area for those who were not strong on a standardized reading test.

The comprehension test further supports both of the previous scores: the better students on the Nelson-Denny did well on the comprehension test (those at the 13th grade level averaged 9.1 on a scale of twelve), while the students below 9th grade showed good comprehension (averaging 7.6 of twelve).

NURSE ASSISTANTS

Student	N-D VOC	N-D COMP	N-D TOT	CLOZE EXACT	CLOZE APP	COMP
1	15.0	13.2	14.8	28	39	7.0
2	14.2	15.0	14.7	59	88	10.0
3	13.1	15.0	13.9	64	86	9.0
4	15.0	10.0	13.6	41	80	9.0
5	13.6	13.2	13.3	46	73	9.0
6	13.1	13.5	13.2	56	96	10.0
7	14.3	10.8	13.1	41	77	9.0
8	14.5	10.0	13.1	41	85	10.0
9	14.0	10.0	12.7	62	91	6.5
10	12.0	13.2	12.7	66	90	10.0
11	12.8	10.8	11.5	53	82	9.0
12	10.9	11.5	11.1	49	90	
13	11.7	10.0	10.9	39	77	7.5
14	11.7	10.0	10.9	41	67	9.0
15	14.5	8.3	10.4	13	14	
16	11.1	8.7	9.8	61	86	9.0
17	8.6	10.8	9.7	57	90	9.0
18	9.6	9.3	9.5	41	72	4.5
19	11.1	8.1	9.5	43	70	
20	8.1	10.0	8.9	43	73	8.0
21	10.5	7.5	8.8	56	90	9.0
22	7.7	9.3	8.3	20	42	5.5
23	8.6	7.5	7.9	21	32	8.0
24	8.1	7.5	7.5	59	90	8.5
25	8.9	6.3	6.9	38	67	6.5
26	6.8	8.7	6.9	39	83	9.0
27	7.0	8.1	6.8	43	82	9.0
28	8.1	6.6	6.8	45	78	9.5
29	8.1	6.3	6.4	28	49	7.0
30	6.8	7.0	6.0	36	65	9.0
31	8.3	BELOW	BELOW			5.5
32	7.7	BELOW	BELOW	13	19	
33	6.6	BELOW	BELOW	21	34	5.0
AVG.	10.7	9.9	10.3	42.6	71.0	8.2

INTERVIEW FINDINGS

The interviews revealed not only those areas where reading care is needed, but also directions in health care which have to be addressed by anyone entering the field. In the area of nursing the greatest need is an awareness of change and an ability to deal with that and use it--rather than becoming outmoded or passed-by. Pat Hamilton, Director of Nursing at Presbyterian Hospital, notes that she would not hire an LPN now and that on her existing staff she has taken the LPNs and given them institutional licensure to create a category of LPN IIs. With increasing specialization, nurses need focus. "we don't have a vehicle to absorb the T-VI LPNs." She added," LPN is the initial step which must be refined by the individual...everyone must plan for a more advanced position." She saw the essential quality needed as "people skills in a crisis situation and process skills in planning."

Dr. Elliott Pierce agreed with Ms. Hamilton that organizational skills were key for a nurse, "If she can listen, take a history and get me the information in a form I can read, it's a big help." Ms. Hamilton also noted that writing skills were the key to progression in the hospital. Pierce went on, "and then if she can read carefully and follow directions, everything has a chance of going OK."

Dorothy Turrieta, Director of Nurses at La Vida LLena, summed up the feelings of the others in noting that most of nursing came down to organization--from the reading and writing done on the job to knowing how to organize schedules and knowing who to see and where to go to get things done."

Ron Pollock in respiratory care at Presbyterian emphasized the ways RT care is changing. Not only must RTs read medical records from doctors and nurses, they must increasingly be able to understand and use computer equipment for care to the extent of reading and interacting with the equipment on the job. He noted that many staff members felt overloaded by the amount of new information. New protocols were presented in small groups and then verified by individual task sessions rather than simply presented in writing. This is in contrast to Steve McPherson at BCMC who wanted people to be able to read journal articles on new protocols and understand not only the procedure but to be able to analyze whether it made sense and was well-written. He noted, "just because it's in print doesn't mean it's good. But you have to read to stay current." When asked for confirmation on reading of this level, a practicing RT said, "Steve is looking for the best of all possible worlds, but that's asking a bit much."

IMPLICATIONS FOR READING IN THE HEALTH OCCUPATIONS

The comments from Steve McPherson have a certain cogency for everyone in Health Occupations. Critical reading is a must whether it is following an administration protocol or reading a patient chart. These two activities, while done everyday, are vastly different and require individual approaches.

Using a protocol means following step by step whether it is administration of medicine or using a machine. Directions are given in discrete units which take the form of simple or complex sentences, but rarely compound sentences. While this may seem odd, it occurs because of the information that is being presented demands temporal or spatial modification. For example, "After checking vital signs, note the..." or "The respirator control switch is located where access...."

On the other hand, a patient chart is necessarily a cumulative instrument where items appear in coordinate position rather than subordinate position as in a protocol. Information in a chart is not discrete as it is in a protocol, i.e., the temperature 72 hours after an operation must be compared with the temperature after 36 hours and 12 hours in order to form a pattern. Because each piece of information must be retained and cannot be left after reading (as can previous sections of a protocol usually)

patient charts use simple and compound sentence forms, especially summary sections.

Suggestions for Reading Exercises

Because of the variety of reading in Health Occupations, exercises must be adaptable to fit the different kinds of demands placed people in the field.

The overt teaching of reading is not recommended; however, reading exercises can be integrated into curricular courses for the benefit of both instructors and students. Because of the advanced level of students in Practical Nurse and Respiratory Technician study, reading exercises should demand problem solving skill work as a simulation of job reading. One of the recurring comments in the interviews was that people in health cannot know everything so they had better know how to look it up.

Reference

One area which seems to cut across all occupational areas is the use of reference skills. This is basic to all fields for primary acquisition of knowledge as well as for constant use on the job. Reference is usually taught academically as dictionary skills or library use (a sure way to lose the students if introduced as such). In fact reference skills apply within the text just as surely as they do outside the text.

Sample Exercise for Health Occupations

This exercise assumes that students have a certain amount of information at hand to use in an integrative exercise. That is, this would be used after material has been introduced and discussed. This could be used for primary integration or as a summary/review exercise.

Given a chart, the student practitioner will have to determine whether the kinds or medication or procedure make sense. This in an integrative exercise calling on all the different kinds of knowledge learned by either Practical Nurses or Respiratory Technicians. This can be used to make students aware of the entire procedure of health care. This type of exercise was suggested by comments from both nursing and respiratory interviews. This could be simple to begin with or very complex, depending on need. The complex examples would actually be easier to find as drug/gas mixtures can interact in curiously synergistic ways. A very simple situation for nurses might be:

1. A nurse reads the chart of a post-op patient and finds the doctor has prescribed demerol p.r.n.; what should the nurse check?

For this example the nurse would have to be aware of the entire chart and any interactions which might occur--the cumulative nature of the information and any recent

additions to the chart. The use of hospital protocols and/or drug manuals can be added as necessary to add complexity.

RESULTS OF THE ELECTRONICS GROUP: ELECTRONICS, INSTRUMENTATION AND CONTROL, AND LASER ELECTRO-OPTICS

Material for this group of technologies will be presented in four sections: readability level of materials, reading test results, interview findings and the implications of the data for reading in electronics.

READABILITY RESULTS

Readability of Texts

The readability levels of the text materials varied considerably from a low of 9.9 grade level for LEOT 6 to a 16.8 grade level for Understanding DC Power Supplies with an overall mean of 13.7. The levels are listed below with a composite score averaged from the Dale-Chall, Fry, Raygor and Flesch readability formulas:

LEOT 6	9.9
LEOT 4	10.4
Microprocessors and Digital Systems	11.0
LEOT 1	11.5
Programming the 8086/8088	11.5
An Introduction to Assembly Language: Programming for the 8086 Family	12.0
Basic Mathematics for Electronics	12.1
Principles of Electric Circuits	12.5
LEOT 10	12.8

Electronic Principles	13.0
LEOT 7	13.3
LEOT 2	13.5
LEOT 4	14.8
LEOT 9	15.3
Electricity and Electronics	15.3
Digital Fundamentals	15.5
Logic Databook	15.8
LEOT 8	16.0
Integrated Cicuits and Semiconductor Devices	16.0
Operational Amplifiers and Linear Integrated Circuits	16.0
LEOT 3	16.3
Understanding DC Power Supplies	16.8
	13.7

The level of the texts at 13.7 is difficult as measured by the readability formulas, calling for a college sophomore reading level. However, as noted in the opening discussion of readability, this is only a part of the whole of reading. The support provided by instruction is not taken into account nor are the reading level of the students and type-of-text content.

While the readability formulas give a figure which is useful for comparison, it is also worthwhile to note the kind of reading done and the depth to which it must be understood. The difference between reading-to-learn and

reading-to-do is clearly illustrated in these texts. Where Understanding DC Power Supplies is clearly the most difficult book as measured by the readability formulas, it is just as clearly a textbook written to teach about DC power. Once the material is mastered, it will only rarely be used as a reference. The Logic Databook, while a grade lower by readability formula, is a dense work with a great deal of information presented in graphic form accompanied by terse statement rather than full technical description. It is not read in the same manner as a textbook but is used as a reference tool in class and on the job.

In like manner, the programming manuals are not read in continuous fashion, but used in reference. A major difference between reading the programming books and the Logic Databook, however, is the use of sequence in programming as opposed to discrete unitary identification and troubleshooting in the databook. In practical terms, this means that the programmer must read in cumulative fashion, i.e., what went before not only is important but determines to a large degree what can come after. The use of reference in programming therefore is not in isolation. The use of reference in the databook is in isolation as one looks up the specifications of a particular piece for identification, troubleshooting or installation. Where a given piece may have to be viewed in relation to other units, it also may not be--a very different situation from a programmer who cannot work in isolated units.

Thus reading in the electronics technologies will follow several different ordering strategies depending on the function of the book and whether the reading is to learn curricular material in school or to work on the job. Additionally, where the bulk of job reading types are covered in training, job reading may well encompass warranty and insurance paperwork which must be read and dealt with appropriately. One further area of job reading is journal and informational reading needed not only to stay current, but to be able to change as the field changes.

Readability of Job Materials

Job materials for the electronics group are different from other occupations in several ways. Albuquerque employers of LEOT and I&C students in particular are engaged in military or corporate projects which preclude handing out actual job materials. Satellite tracking equipment, laser navigation instruments, and military communication vehicles were some of the projects viewed in which materials were not collected. The graduates not involved in secret work use repair and specification manuals, read worksheet and warranty forms or perform assembly routines involving little reading. Virtually every interview concluded that graduates should be able to read journals in the field if they were to move beyond entry-level positions.

Because of the limited collection of job materials and the uniformity of response toward the reading of professional journals, a sampling of the journals was made, marking a desired rather than an actual level of reading for on the job. The four journals are Laser Focus, Solid State Technology, IEEE Transactions on Instrumentation and Control, and Lasers and Applications. The four journals had an average readability level of 16.0.

TESTING RESULTS

The results of the reading tests will be presented in tabular form with a discussion following. The first discussion will cover the Nelson-Denny Reading Test scores listed under N-D TOT in the tables.

Electronics 1

	N-D VOC	N-D COMP	N-D TOT	TECH CLOZE EXACT	TECH CLOZE APP	GEN CLOZE EXACT	GEN CLOZE APP
1	15.0	15.0	15.0	38	56	42	92
2	15.0	15.0	15.0	35	55	36	89
3	15.0	15.0	15.0	45	88	43	91
4	15.0	13.5	15.0	20	42	43	85
5	15.0	14.1	15.0	33	51	43	87
6	15.0	14.7	15.0	33	58	45	89
7	15.0	14.4	15.0	13	35	26	60
8	15.0	15.0	15 0	27	45	38	87
9	15.0	13.8	14.9	20	40	42	83
10	15.0	13.2	14.2	22	40	38	81
11	14.7	13.8	14.2	15	31	30	66
12	14.9	13.2	14.0	27	64	40	87
13	13.8	14.1	13.8	18	27	30	74
14	14.8	12.2	13.7	33	64	40	79
15	13.8	13.8	13.6			17	25
16	12.7	13.8	13.2	20	40	23	60
17	13.5	12.2	12.9	18	38	38	79
18	13.5	12.8	13.1	18	27	23	57
19	13.3	12.2	12.8			28	64
20	12.7	12.2	12.5	22	47	34	77
21	13.3	10.0	12.0	25	49	36	74
22	11.1	11.5	11.3	11	31	32	66
23	12.7	9.3	11.1	16	31	23	51
24	14.0	6.3	10.4	4	9	11	34
25	11.4	8.7	10.0	77	21	34	58
26	6.6	6.0	6.0	0	8		
AVG.	13.7	12.5	13.2	25.7	41.2	32.4	71.8

ELECTRONICS 4

	N-D VOC	N-D COMP	N-D TOT	TECH EX	TECH APP	GEN EX	GEN APP
1	14.6	12.8	13.6	27	58	34	64
2	14.4	12.2	13.4	20	40	30	72
3	14.6	10.8	13.3	22	53	36	77
4	13.9	12.8	13.3	15	38	19	70
5	14.5	10.0	13.1	9	33	28	68
6	12.9	12.2	12.6	24	40	30	57
7	13.8	9.3	12.1	20	47	28	64
8	12.4	10.0	11.3	11	38	21	68
9	12.4	10.0	11.3	20	54	23	64
10	8.9	12.8	10.9			26	62
11	13.6	7.5	10.9	22	38	34	62
12	10.5	9.3	9.6	9	27	21	57
13	8.3	9.3	8.8	4	16	15	23
14	9.2	7.0	7.9				
15	7.3	7.5	6.8	13	27	19	47
16	7.7	6.4	6.0	2	5	11	23
AVG	11.8	10.0	10.9	15.6	36.7	25.6	58.5

INSTRUMENTATION AND CONTROL 4

	N-D VOC	N-D COMP	N-D TOT	TECH CLOZE EXACT	TECH CLOZE APP	GEN CLOZE EXACT	GEN CLOZE APP
1	15.0	15.0	15.0	25	49	53	96
2	15.0	15.0	15.0	38	69	38	77
3	15.0	14.4	15.0	24	51	36	60
4	15.0	15.0	15.0	36	67	57	96
5	15.0	13.5	15.0	20	44	17	62
6	15.0	14.1	15.0	24	49	30	83
7	15.0	14.7	15.0	33	54	45	81
8	15.0	15.0	15.0	40	62	47	91
9	14.2	15.0	14.8	31	67	36	83
10	14.8	11.5	13.6	11	29	21	60
11	14.2	12.2	13.3	24	41	32	72
12	14.2	10.8	13.0	20	42	28	74
13	11.1	13.8	13.0	16	27	21	53
14	13.1	10.0	11.8	4	7	32	70
15	12.4	9.3	10.9	13	36	19	43
AVG.	14.2	13.1	13.9	23.9	46.1	32.8	71.8

LEOT 4

	N-D VOC	N-D COM	N-D TOT	TECH EX	TECH APP	GEN EX	GEN APP
1	15.0	15.0	15.0	27	51	47	94
2	15.0	15.0	15.0	29	51	40	85
3	15.0	15.0	15.0	33	66	30	87
4	15.0	15.0	15.0	24	53	40	81
5	15.0	15.0	15.0	31	67	40	87
6	15.0	14.7	15.0	34	71	42	87
7	15.0	13.2	15.0	25	61	47	100
8	15.0	15.0	15.0	27	56	44	87
9	15.0	13.8	14.9	31	58	44	83
10	13.6	13.8	13.6	24	45	17	70
11	14.7	11.5	13.5	22	56	32	83
12	14.3	10.0	12.9	22	27	34	74
13	10.1	13.2	11.8	11	24	17	45
14	10.9	8.1	9.3	13	33	14	41
AVG	14.1	13.5	14.0	25.2	51.3	34.8	78.8

The electronics group will be discussed as a whole because it forms one entity coming out of a shared course: Electronics I Lab. In looking at the Nelson-Denny scores, it is interesting to note that the first trimester at 13.2 grade level is 0.3 ahead of the combined averages of the three fourth-trimester groups. This is in line with the results in other areas where Nelson-Denny scores have been roughly equal. The surprising result is the discrepancy between the Electronics 4 students at 10.9 and the others at 13+. However, when Electronics 4 is viewed by ethnic background with only 3 of 16 students listing themselves as Anglo, the results are not surprising as the Nelson-Denny is normed for a college-oriented Anglo population.

The cloze results show great similarity for the Electronics 1, Instrumentation and Control, and LEOT with the Electronics 4 group consistently behind as one might expect with a Nelson-Denny three grades behind. Each group took two cloze tests, one general and one technical, which were scored with both the exact word and appropriate word grading measures. Forty-four percent correct indicates that material is suitable for instructional purposes (with the support of a classroom) while the 57 percent level indicates the material is suitable for independent reading.

The technical cloze test was selected on the basis of interview information indicating that reading on the job in the three electronics areas meant more than being able to

read present materials. Emphasis was placed on the ability to read materials independently and on an on-going basis in order to remain current with fields which change a great deal year to year. Additionally, comments indicated the increasing overlapping nature of the three areas as processors become more sophisticated and lasers take on measurement and process tasks. With this in mind, a passage was chosen which was related to the three areas but not material which had been previously studied. The training effect therefore was not expected to be as great as in some other occupational fields, e.g., in a passsage on turbochargers, the fourth trimester diesel students scored much higher than the first trimester. While there is a difference, it is not great. As can be seen from the tables on the technical cloze, the I&C and LEOT students were inside the instructional range while the Electronics 1 group missed by three points and the Electronics 4 group missed by seven on a cloze which has a readability score of 17. There is a training effect when Electronics 1 and 4 are compared. Electronics 1 group with a reading level of 13.2 might be expected to do well, but to have the Electronics 4 do as well as they did coming from a 10.9 Nelson-Denny would seem to show that they have some familiarity with the material.

The general cloze was selected as a passage of news with which the students might be familiar, but not a subject area that they would likely have studied. The selected passage was taken from the front page of the Albuquerque

Journal of June 23, 1986, concerned bomb blasts in South Africa and had a readability score of 13.1. The students did well with this test as it was at their reading level with Electronics I at 72, Electronics 4 at 59, I&C at 72 and LEOT at 79, all at the independent level.

INTERVIEW FINDINGS

The interview results were most interesting as they focused as much on future needs as on present demands. Where students in most of the other occupational programs at T-VI feel the rush into the future, nowhere is there the pressure found in the electronics group. Peter DiPalo of Sperry summed up this sense in saying, "Manuals are anachronisms." Indeed, by the time they get into print they are out-of-date.

The most common job reading materials for this group in areas where they have been trained are tech manuals, schematics, component catalogs, tech journals, and work orders. Peripheral, but important, reading materials on the job include warranties and other insurance-related work, billings and associated office paperwork, and employee guides and profit-sharing plans. There was no clear consensus as to whether the tech or general reading was more difficult. Mike Watson of Missouri Research noted, "If they are at all familiar with the tech material, then that's easier than general reading."

Writing needs were equally varied. Certainly, the keeping of accurate logbooks is the most important writing done on the job for all three areas of specialization. Using the logbook as the information store, workers have to write progress reports, quality control notes, verification of

specifications, procedural reports, work orders, and billing and warranty write-ups. With so much dependent on the logbook, managers placed great emphasis on the organizational skills of workers. One noted, "a notebook is good if someone else can pick it up and understand it." Another said, "It is writing so others understand."

There was a consensus that tech writing was more difficult than general writing, usually expressed in terms of the ability to fill out technical forms and formats correctly. In contrast, Bob Pixton of CVI Lasers noted that general English was more difficult and cited aspects of general writing as they apply to technical work, neatly summing ideas expressed by others. In particular, he noted organizational skills, precision in description, clarity of presentation, and care in mechanics such as spelling and grammar.

In summary, entry-level workers can read adequately on the job when familiar with the materials. While slightly outside the purview of a reading study, there were comments on following directions and protocols precisely, even though the material was readable. Said Maria Erikson of Computouch, "Training must emphasize care. He was perfect in troubleshooting chips, but had no perspective or overall comprehension of fragile mechanisms."

The other important point was that while the reading and writing skills of entry-level workers are adequate now,

they must improve if the worker is to progress in the field. This applied equally for electronics, I&Cs and LEOTs. Chris Calvert, Service Manager at Businessland, noted that entry-level writing for his instrument people was confined to cover letters with technical notes written to someone back at the factory: "techie to techie." He noted that if a person was to move from being an entry-level technician, he would have to be able to write good general English. In like manner, James Bowen, a supervisor at Helionetics, and Bob Pixton at CVI both noted that LEOTs may have to read technical journals at entry-level, but certainly would if they were to progress beyond that level.

IMPLICATIONS FOR ELECTRONICS READING

Overall T-VI graduates in the Electronics field read very well as witnessed by the large number of 13+ reading scores. This is a necessity given the level of present reading and the reading demands which can be expected in the future.

Discussions during the interviews emphasized the convergence and growing interdependence of the three areas. Where instrumentation and control used to mean bourdon tubes and electrical meters, information is now digitized and computers can be programmed for automatic control. In like manner, where lasers and electro-optics used to be an arcane area of research science, it is now part of everyday life in supermarkets, auto factories and telephone communications. Industrial robotics is a perfect example of the uniting of these two areas with lasers being used for precise measurement for control functions. Underlying these advances is the progress in computer technology, which, at the limits of research, is looking at optical rather than electronic switching.

The implication of this convergence is clear: electronics, I&C, and LEOT will continue to have important branches in research, but direct application in daily life will be increasing. Joel Gellman, head of LEOT at T-VI stated that, "We train for research and development." This

has worked in the past and will continue to work in the future for that part of LEOT which is concerned with R&D; however, Safeway, General Motors and telephone companies do not need R&D technicians to do troubleshooting and repair work.

These implications apply to reading and writing directly in the way information is recorded, recalled, and used. One of the characteristics of research and development work is the recording all pertinent information: material, procedure, and result. Both positive and negative results are recorded because both are important, especially in light of any variations of material and procedure involved. This is necessary not only for the ability to replicate the experiment but also for establishing date and procedure for patents and proprietary rights. Troubleshooting on the other hand is a known linear sequence proceeding in a top down fashion until the piece is operational.

Reading in R&D must be cumulative in nature as previous variations in material and procedure must be taken into account. Then in recording results, note must be taken in what happened as an end product of the protocol followed. On the other hand, reading in troubleshooting is discrete, concerned only with the part under consideration while recording of information is limited to material fixed or replaced. Necessarily, reading in an R&D setting must be more involved than in troubleshooting as the researcher must

be able to follow linear procedure as well as the troubleshooter, but must additionally be able to go beyond, dealing with results and at least a tentative discussion of why the results occurred.

Teaching reading skills to students in the electronics technologies by direct instruction would probably not be very productive at best and would be alienating at worst. Far more useful, is incorporating reading strategies into the actual content instruction of the three fields. In light of the convergence of electronics, I&C and LEOT in application and the similarity in technical report format in research, a useful exercise for intermediate students would be in the differentiation of presentation types used in the fields.

In practice, this would mean a discussion of formats as they came up naturally in course content, rather than as a separate class on formatting. Thus in reading details of an experiment and discussing the results, the teacher could point out the pattern of presentation and ask questions about the way the material is presented at the same time as discussing the content. When this is done regularly, the students will gain an awareness of the interrelatedness of the technical format with the type of material being presented, i.e., format follows the function of what is being presented and the method of presentation is not random. After several such discussions, the students will

know to look at presentation and use that knowledge in order to get at the content, rather than having the form be a hindrance. Thus reading exercises can be used to help teach the format of the logbook, outlining how it is to be set up as a whole, focusing on aspects such as experimental format reporting, or materials and protocols.

In summary, by introducing students to technical journals early in their training, several cognitive and affective goals can be accomplished at the same time even though complete comprehension of the material read may not be achieved due to the complexity of the content and a lack of background. Such exposure will enhance their background just as it achieves the other benefits.

The first benefit is an awareness of the level they will be expected to achieve by the time they finish. It is one thing to tell students that they must be good readers and knowledgable in various aspects of their fields; it is quite another for them to see the reality themselves.

Secondly, students will become aware of different formats of presentation for different purposes. Experimental presentation might come through IEEE publications while different kinds of technical description (physical, functional and operational) are used in product introductions in journals such as Laser Focus, Lasers and Applications, or Solid State Technology.

Finally, after seeing a number of articles, they will begin to see what the scope of their field is in terms of both research and application. When presented with the range of opportunity in their field, they can see the types of jobs available to them at the end of training and whether they want to be a research technician or an installation, assembly, or maintenance tech.

SUMMARY

In reviewing the findings of the report, several points need discussion: the adequacy of student reading for the job, writing as a key to advancement, the use of readability formulas, and the means of reading preparation in the occupations at T-VI.

T-VI graduates are generally able to read adequately on the job as long as the reading remains within the area of the job they have studied at T-VI. The implications are twofold: most of the time the job reading falls into an area the graduates have studied; however, there are areas in each occupation which fall outside the curriculum. Therefore, while most students read adequately most of the time, there is a distinct need for teaching students how to read in their occupation so that when faced with an unfamiliar situation they have strategies for coping with the unknown.

Writing needs are being adequately met for entry level. However, in almost all occupations studied, writing is one of the keys to advancement. Clear, concise, understandable writing is needed, especially where there is contact with other companies. A poorly written letter or technical description reflects not only on the individual but also on the company. Firms are hesitant to promote individuals who

are unable to represent the company well, even if technically competent.

Readability formulas are used throughout T-VI for a variety of purposes and with varied levels of understanding. To deny the use of a book to a department purely on its readability level is absurd. The readability level of a book might be the starting point of a discussion of the suitability of a book for a given group, but along with the readability level, one must consider the educational background of the group, the content area background of the group, the motivation of the group, the purpose of the book with the group, as well as the content and the grammatical and rhetorical structures of the book. A consideration of all these features must accompany any use of a readability formula because books can be "written down" to give a lower score on readability formulas just as motivated students with background in an area can read books which score well above what they "should" be able to read. As noted in the previous discussion of readability formulas, they only measure surface syntactic items and omit any consideration of meaning. Therefore, their use should reflect that limitation. This is not to say that they should be eliminated, only that they should be used with understanding.

Reading instruction should occur in the occupations as an integral part of the curriculum. The present system of

remediation for those inadequately prepared for an occupation does not address the reality of the workplace. As noted in each individual occupational section, reading should not be taught explicitly as reading, but should be taught functionally as just another skill needed in the field. To a point, each occupation teaches reading already as in instruction in charts, schematics, exploded views and diagrams. Just as these items are not taught in isolation neither should be reading because, at the most fundamental level, reading on the job means knowing how to get information. It means knowing how to access information whether in a reference manual, microfiche, or on-line computer search and then how to integrate that knowledge to solve the problem at hand. With every occupation studied moving toward electronics and computer use, not only are job descriptions and the methods of doing those jobs changing, but also the types and methods of access of information for those jobs.

Where most graduates can read most material on the job, that may not be the case in the future unless steps are taken to integrate reading skills into the curriculum.

PROTOCOLS AND SUGGESTIONS FOR STUDYING OTHER OCCUPATIONS

The procedure used in this study worked well and could be used to study other areas without substantive change. The process of collecting training and job material, conducting interviews, and testing students are all essential in a thorough needs analysis. The outline in the methodology and instrumentation section as well as the text and interview forms contained in Appendix B can provide a suitable structure for further study; however, there are several suggestions in being able to complete a study accurately and expeditiously.

Ideally, research should be organized at the same level as curricular decisions for several reasons. (1) Research should grow out of curricular needs. (2) Research should directly affect curricular decisions. (3) Implementation of research findings demands review at the curricular decision level.

Everyone involved in research should be knowledgable of the project, the project's goals, the benefits coming from the project and be in accord as to the value. With agreement, research is quick, clean and agreeable. Without agreement, differing priorities cause delays, less thorough work, and a certain amount of hostility.

Time should be considered from several vantage points. (1) There are better and worse times within a trimester for research. (2) Reading research needs a block of time and students who remain through the testing period. These considerations demand flexibility on the parts of researchers, administrators and teachers as all have their own priorities.

APPENDIX A: DISSEMINATION OF THE STUDY

CONFERENCES:

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New Mexico International Reading Association, Hobbs, NM, "Reading on the Job," October 1985.

TESOL National Convention, Los Angeles, CA, "Vocational Reading for LEP Students," March 1986.

New Mexico Bilingual Education/New Mexico TESOL Conference, Albuquerque, NM, "Getting the Job Done: Vocational Reading for the L1 and L2 Student," March 1986.

Mountain Plains Adult Education Conference, Albuquerque, NM, "Vocational Reading in Adult Education," April 1986.

Adult Educational Research Conference, Syracuse, NY, "Vocational Reading in Training and On-The-Job," May 1986.

Rocky Mountain Regional TESOL, Albuquerque, NM, "Reading Assessment in Occupational Settings: Schema, Function, and Depth," October 1986

Western College Reading and Learning Association, Albuquerque, NM, "Reading Assessment in Vocational Education," April 1987

Eastern Michigan Conference on Languages and Communication for World Business and the Professions, Ypsilanti, MI, "Reading and Writing Assessment in Occupational Settings: Schema, Function, and Depth," May 1987.

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Proceedings of the Adult Educational Research Conference, Syracuse, NY, "Vocational Reading in Training and On-The-Job," May 1986.

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APPENDIX B: ASSESSMENT FORMS

Business Questionnaire

Name _____

Business_____

Position _____

What are the reading tasks at entry-level?

Which of these tasks seem to be most difficult?

General/Technical?

What are the most commonly used types of print materials?

Must they understand knowledge from reading?

Apply knowledge?

Evaluate information?

Do entry-level people make decisions based on reading?

Does the person work alone or in groups?

Does the person have to produce writing based on reading?

Does the person initiate writing or only respond?

Does writing seem more difficult than reading for the entry-level person?

If the person writes, are there problems with technical English or general English?

Any other comments...

Text Form

Name of text

Occupation

Training or job?

Page number

Paragraph or section number

Purpose of the text

Material content

Overt rhetorical form

Other forms

Format

Reference to a visual?

Readability scores

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Selinker,L., M.Todd-Trimble and L.Trimble, "Rhetorical-Function Shift in EST Discourse," TESOL 12(3) 1978

The three Selinker, et al. articles, while written ten years ago, are the most insightful articles yet written on the rhetoric of technical writing. They show the limitations imposed on technical writing by the nature of what must be expressed.

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The book in discussing psycholinguistics and reading. Written for a general audience, it presupposes no great linguistic knowledge.

Smith, F., Psycholinguistics and Reading, Holt, Rinehart and Winston, New York, 1973

The follow-up book to the above. More depth than the previous.

Sticht, T., "Comprehending Reading at Work," in Cognitive Processes in Comprehension, edited by M.A.Just and P.A. Carpenter, Lawrence Erlbaum Associates, Hillsdale, N.J. 1977

A look at the tasks of reading on the job and strategies for coping; does not deal with cognitive elements as the book title would have you believe.